

Community Outbreak of Norovirus Associated with Contaminated Drinking Water, Oklahoma, 2008

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Background: Outbreak Setting

- Lakeside community
 - Located in Delaware County, Northeast OK
 - Residential properties
 - Primarily used as second homes during weekends and holidays
 - 30 condominiums and 12 lakefront homes
- Marina store and boat rental company available to general public
- Drinking water system: permitted, non-community well water system



Initial Notification of Suspected Outbreak

- July 7, 2008: Oklahoma State Department of Health (OSDH), Acute Disease Service (ADS) notified of suspected outbreak
 - At least 13 individuals experienced gastroenteritis
 - Illnesses occurred among residents and guests after staying at the lakeside community for the Fourth of July weekend
 - Outbreak investigation initiated
- Oklahoma Department of Environmental Quality (DEQ)
 - Boil advisory issued July 8: fecal coliform + samples



Methods: Epidemiologic Investigation

- Retrospective cohort investigation
 - Attempted to interview all residents and guests who visited at least one day from June 25 through July 11, 2008, or
 - Rented a boat from the marina store during the same timeframe
 - ADS personnel conducted interviews using a standard outbreak questionnaire to obtain:
 - Demographic information
 - Clinical history
 - Exposure information
 - Specimen collection



Methods: Case Definition

- Confirmed case:
 - Person who visited the lakeside community from June 25 through July 11 and developed diarrhea and/or vomiting within 72 hours of staying or visiting the community with laboratory evidence of norovirus.
- Probable case:
 - Person who visited the lakeside community from June 25 through July 11 and developed diarrhea and/or vomiting within 72 hours of last date of visitation.



Environmental Investigation Methods

- Evaluation of well water system
 - History of water quality measurements, chlorination records and maintenance
 - History of maintenance and modifications to the system
- Evaluation of sewage treatment system
 - Distribution of the system compared to water system
 - Potential for cross connections and contamination of the water system
- Environmental sample collection



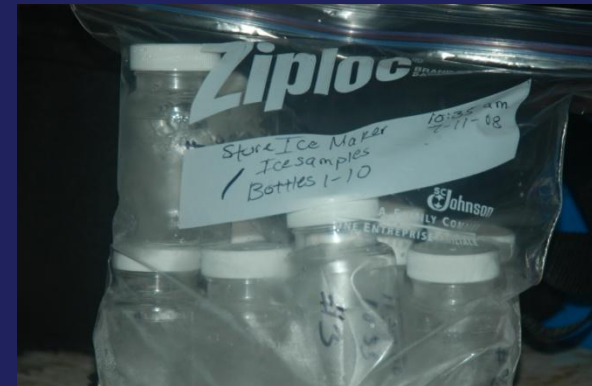
Laboratory Methods: Clinical Specimens

- Stool specimens requested
 - All persons that met the probable case criteria
 - Submission via clinical visit or county health department collection
- OSDH Public Health Laboratory
 - Culture for enteric pathogens, Shiga-toxin by EIA
 - RT-PCR testing for norovirus genogroup I and II
- CDC
 - Norovirus genetic sequencing



DEQ Laboratory Methods: Water samples

- Water samples collected by ADS and DEQ
 - Well system, residences, and marina store
 - Ice and water heater samples from residences and store
- DEQ laboratory testing
 - Presence/absence of fecal coliforms
 - Presence/absence *E. coli*
 - Total coliform and *E. coli* most probable number methods



Laboratory Methods: Norovirus RT-PCR

Testing of Water Samples

- Water samples collected for norovirus RT-PCR
 - Ultrafiltration sample from well
 - Marina store ice machine sample using surfactant solution
 - Backflush sample from sand filtration system
 - Additional water heater samples



Results: Case finding and retrospective cohort

- Total number of residents/visitors interviewed: 120
 - 114 (95%) residents and guests
 - 6 (5%) boat rental customers
- Number of cases: 62 (52%)
 - 7 (11%) confirmed norovirus GI
 - 55 (89%) met probable case definition



Demographic information of Cases and non-ill

	Cases (N=62)	Non-ill (N=58)
Age (Range & Median)	4-90 (median: 34 years)	2 months-81 (median: 38)
Gender		
Male	31 (50%)	31 (53%)
Female	31 (50%)	27(47%)
State of Residence		
California	1 (1.6%)	1 (1.7%)
Illinois	1 (1.6%)	1 (1.7%)
Kansas	2 (3.2%)	0
Kentucky	4 (6.4%)	0
Missouri	3 (4.8%)	3 (5.2%)
Oklahoma	46 (74.2%)	51 (87.9%)
Texas	4 (6.4%)	2 (3.4%)
Virginia	1 (1.6%)	0

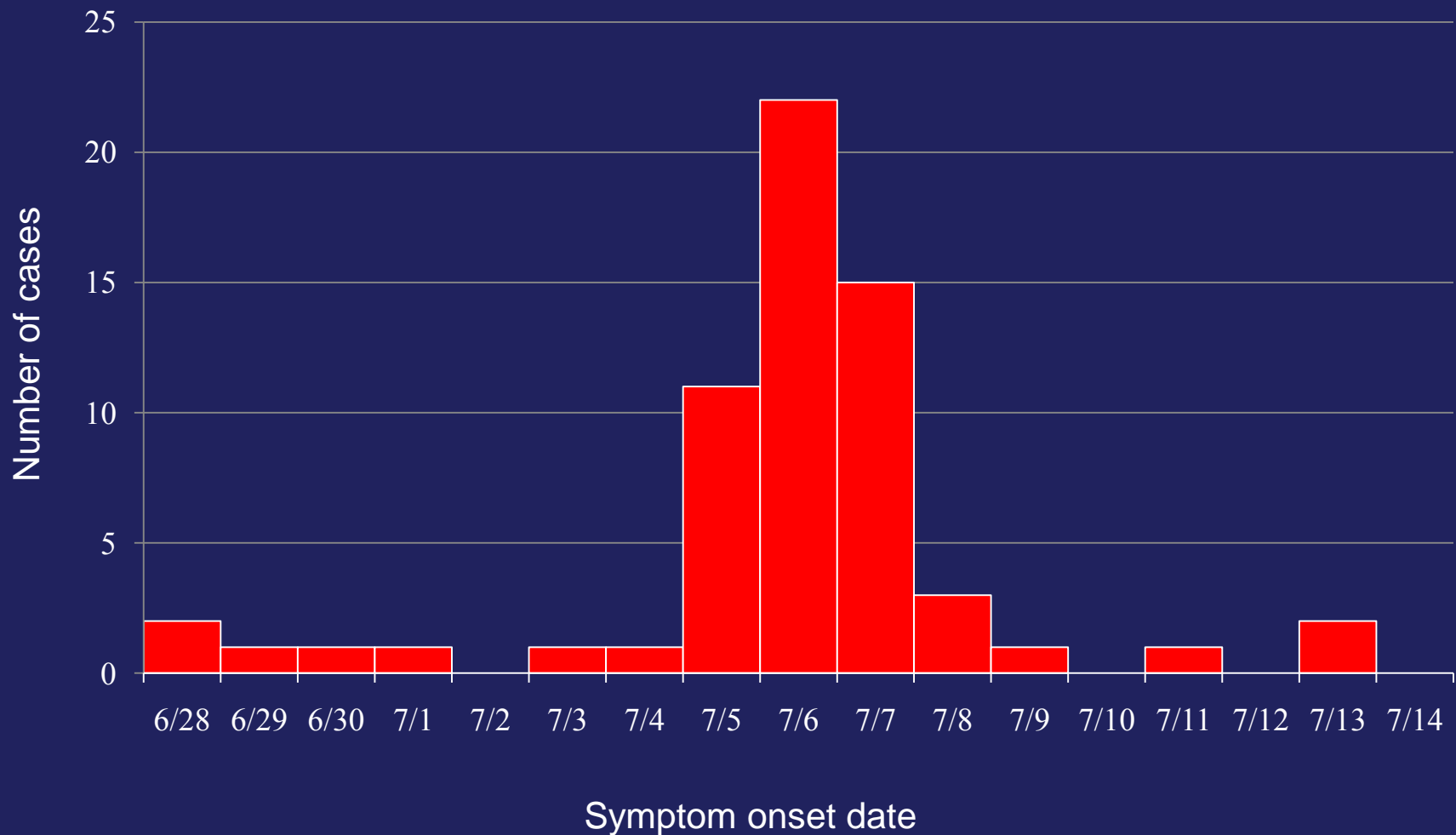


Frequency of Symptoms Reported by Cases

Symptom	Number (%)
Fever	25 (42%)
Abdominal cramps	53 (85%)
Loss of appetite	51 (86%)
Diarrhea (≥ 3 loose stools/24 hours)	54 (87%)
Watery Diarrhea	45 (83%)
Bloody Stool	2 (3%)
Mucous in Stool	4 (6%)
Vomiting	36 (58%)



Date of Symptom Onset of Cases, Lakeside Community Norovirus Outbreak Investigation, Oklahoma, June - July 2008 (N=62)



Association of Lakeside Community Exposures and Gastrointestinal Illness, Norovirus Outbreak Investigation, Oklahoma, July 2008

	Exposed		Not exposed		Relative Risk
	Case	Non-case	Case	Non-case	(95% CI)
Townhouse ice	38	9	21	24	1.73 (1.23, 2.44)
Townhouse tap water	28	11	27	22	1.30 (0.95, 1.79)
Marina faucet water	1	1	59	55	0.97 (0.24, 3.91)
Marina ice	16	8	45	48	1.38 (0.97, 1.96)
Townhouse ice or townhouse tap water	44	15	13	19	1.84 (1.18, 2.68)
Townhouse ice or marina ice*	43	11	19	47	2.77 (1.85, 4.14)
Water exposures combined^	51	19	11	38	3.25 (1.89, 5.57)
Swim in Lake water	42	35	20	22	1.15 (0.79, 1.67)
Any lake water exposure	56	51	6	7	1.03 (0.91, 1.16)

*Ice produced from the marina well water source

^Water exposures combined include any community well water system exposure such as townhouse ice, townhouse tap water, marina ice, or marina water.



Results: Environmental Investigation

- Environmental assessments
 - Community water supply did not meet standards for construction or maintenance
 - Potential for cross-connections and contamination from sewage treatment system and lake



Environmental Specimen Results for Bacteriologic Testing Performed by the Oklahoma Department of Environmental State Laboratory

Collection date	Environmental Specimen Description	Results
7/7/2008	100ml water sample (Condo #27)	Positive coliform and Fecal coliform
7/7/2008	100ml water sample (Marina Water)	Positive coliform and Fecal coliform
7/11/2008	100ml water sample (Condo #1 – water heater)	Positive coliform (TC=42) and Fecal coliform
7/11/2008	100ml water sample (Marina ice maker)	Positive coliform (TC=14) and Fecal coliform
7/11/2008	Ice (Condo #18)	Positive coliform (TC=2) and Fecal coliform
7/11/2008	Ice Sample (Condo #11)	Positive coliform (TC=>200), negative fecal coliform
7/16/2008	100ml water sample (Well #1)	Positive coliform (TC/MPN=>200.5) and Fecal coliform (EC/MPN=>200.5)



CDC Enteric and Environmental Specimen Results for Norovirus RT-PCR Testing

Norovirus laboratory results:

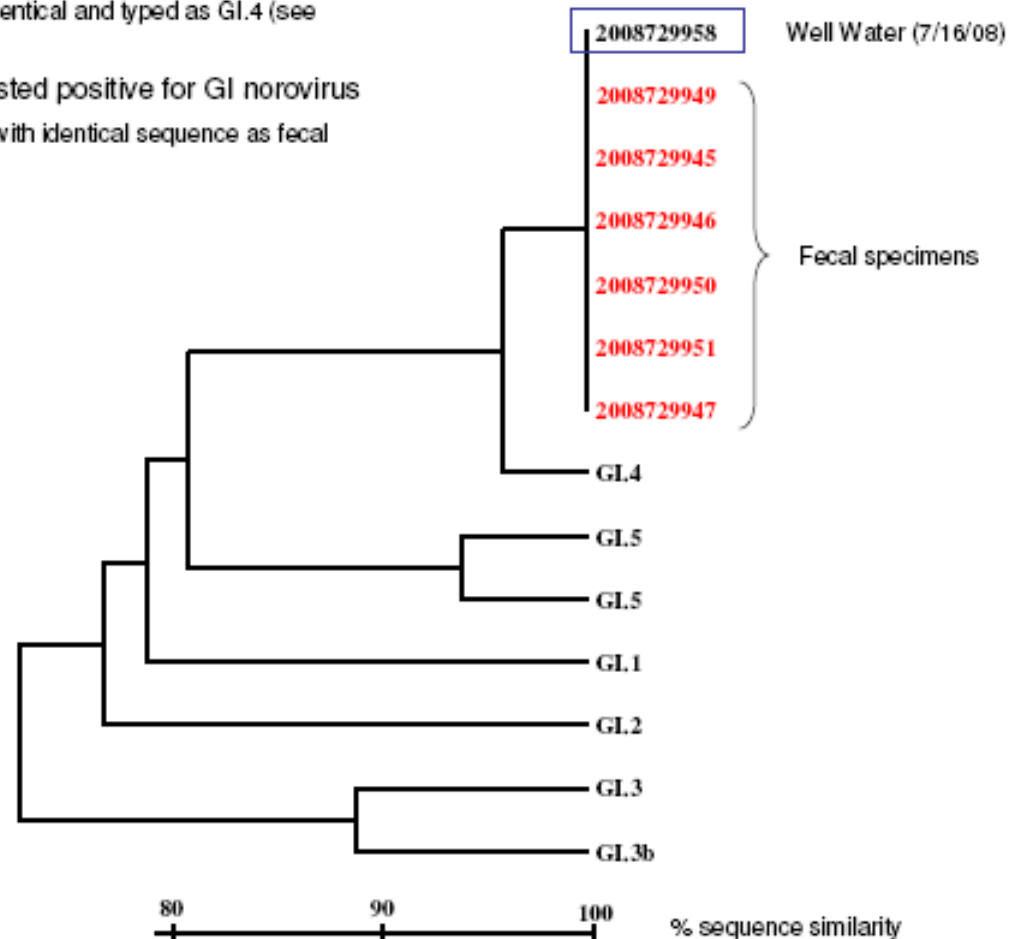
- 7 of 9 fecal specimens tested positive for Genogroup (G) I norovirus

>> Typing by sequencing confirmed all strains identical and typed as GI.4 (see phylogenetic tree)

- 2 of 5 environmental water samples tested positive for GI norovirus

>> 1 sample (well water) was confirmed as GI.4 with identical sequence as fecal strains

CDC Dash numbers:



Recommendations

- DEQ issued an emergency order requiring discontinuation of the well system
 - Order based on epidemiologic, environmental, and laboratory results
 - Community connected to nearby rural water system
- Recommendations to residents:
 - Discard initial batches of ice, coffee, and flush water using household appliances
 - Run tap water for at least one minute to drain pipes



Summary

- Epidemiologic, environmental, and laboratory results indicated an outbreak of norovirus was due to a contaminated well water system
- Environmental assessment indicated the well system did not meet construction and maintenance standards
- First reported application of the dead-end hollow fiber ultrafiltration sampling method to successfully recover norovirus in an outbreak setting



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